Creating an Arkansas Research and Education Optical Network

by

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A white paper addressing the development of a high bandwidth research network in cooperation with the initiatives of the Southern Governors' Association and the National LambdaRail Research Network

Introduction

The purpose of this white paper is to introduce the reader to **AREON** – **Arkansas Research and Education Optical Network** – a new education and research fiber optic network that will span the state of Arkansas and join with surrounding states to form a regional optical network.

This network is one of a growing number of optical networks that the higher education community is building, both regionally and nationally. One important new network, the National LambdaRail (NLR), is a major initiative to provide a national scale infrastructure for research and experimentation in networking technologies and applications. NLR is designed to meet the computational and networking research needs projected for the next decade. NLR provides researchers with faster network connections and access to research resources nationally.

Figure 1: National LambdaRail Architecture

The Southern Governors' Association (SGA) adopted a policy resolution in 2002 in support of work underway within the Southeastern Universities Research Association (SURA) member institutions to build a high performance computational network grid. The Southern eCorridors Project emerged from the SURA initiative. The governors endorsed the creation of fiber optic grids for connecting the major regions in the South. Governors from a number of the states represented by the SGA, including Governor Mike Huckabee in Arkansas, have announced their support for the eCorridors Project through special funding of optical networks within their respective states.

Background

Since the early days of the Internet, research universities have been instrumental in developing new networking technologies and applications. In 1986 the National Science Foundation (NSF) funded the creation of NSFnet, a national Internet backbone devoted to research and education. The University of Arkansas established its first connection to the Internet in 1987 through a NSF grant that created MIDnet, a regional network that shared networking infrastructure to provide Internet connections for universities in eight Midwestern states. Through a series of NSF grants beginning in 1990, the University of Arkansas, along with other Arkansas universities, colleges, and public libraries, created a statewide network, ARKnet, to provide for higher education Internet connectivity.

By 1997 public use occupied much of the Internet, increasing the demand for services in such great context that research universities soon discovered the Internet in its present form was not suited for some

research requirements. With funding support from the National Science Foundation, the higher education community created a new national network devoted to research and education. Internet2 was formed and became operational in 1998. The University of Arkansas joined with many of the original MIDnet institutions to create the Great Plains Network, a regional network devoted to providing high-speed network connections to Internet2 for its members. Internet2 now connects over 200 research universities, including Arkansas State University, the University of Arkansas at Little Rock, the University of Arkansas for Medical Sciences, and the University of Arkansas, Fayetteville.

At Issue

Highly reliable, scalable, adaptable, and secure networks are essential to the higher education community today to meet its missions of research and education. Researchers and their students continue to stretch the bounds of the networking infrastructure. Besides the insatiable demand for bandwidth, new applications such as grid computing require low latency, new protocols, and greater security. These are pressing the envelope of what today's Internet and Internet2 networks can deliver. Regional, national, and even global fiber optic networks promise relief of many of the constraints.

The telecommunications industry has been the basis upon which existing wide area networks have been built. Data networks traverse the same infrastructure that communications providers built to carry telephony. The costs for very high speed data circuits are often

prohibitive, and providers often are unable or unwilling to provide services needed by researchers.

The dot-com bust of the 1990s has provided opportunities for organizations, including higher education institutions, to acquire rights to use fiber optic cabling already buried in the ground at extremely attractive prices. Once the fiber optic cabling plant is available to institutions, they can build networks that are bound only by the limitations of the photon and the technology available to transmit and receive light. Some of the advantages of an optical network include:

- Waves: rather than being limited to a single stream of data between transmission points, dense wave division multiplexing (DWDM) provides the means for transmitting multiple streams of data simultaneously over a single fiber optic strand. Multiple light waves, or lambdas (essentially electromagnetic radiation of select frequencies, or colors), are combined through an optical device such as a prism, transmitted together over a single fiber optic strand, and then separated at the other end into the original light waves. Each light wave can carry its own data encoding and is transmitted without interfering with the other waves.
- Bandwidth: data transmission speeds that were previously limited to the tens and hundreds of megabits (millions of bits) per second now hold the promise of ten gigabits (billions of bits) per second and beyond. With DWDM, multiple ten gigabit waves can be combined to provide 40 gigabits per second or more.

Optical networks offer institutions the opportunity of building infrastructure today that will meet needs for ten or more years. As technology and needs change, the equipment used to light the fiber can

be changed out; the fiber optic cabling itself remains the common enabling factor.

Opportunities to acquire long term rights to use for fiber optic cable already in the ground, while plentiful and relatively inexpensive even a year ago, are becoming harder to find. The telecommunications industry is re-evaluating the value in the cable plants that they own or have acquired through dot-com acquisitions and is becoming less willing to sell off that infrastructure if it might mean diminished revenue for their services into the future. Institutions are rushing to complete acquisitions before these opportunities dry up.

The Solution

The University of Arkansas advocates the creation of a new optical network that spans the state of Arkansas. **AREON – Arkansas Research and Education Optical Network** – would provide the much-needed link for the state of Arkansas to become a viable, contributing part of the National LambdaRail initiative. AREON will be the underlying network that is built and funded through the Arkansas eCorridors program recently introduced to the Arkansas legislature and endorsed by Governor Mike Huckabee.

Conceptually, AREON will initially consist of one or more fiber optic rings that form a backbone infrastructure for the major research universities to connect as shown in Figure 2. Extending the backbone to the four current Arkansas Internet2 members will be the first priority, including the University of Arkansas, Fayetteville, the University of

Arkansas at Little Rock, the University of Arkansas for Medical Sciences, and Arkansas State University.

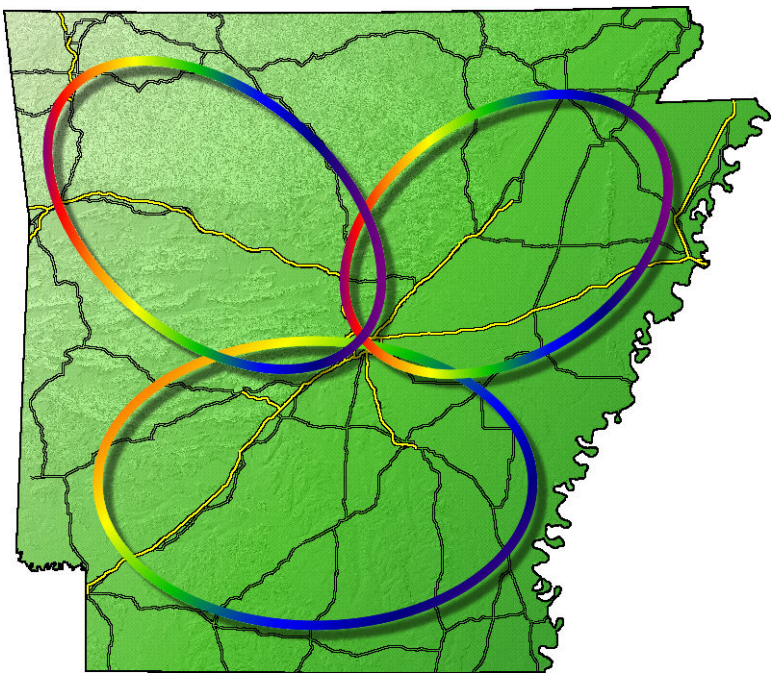

Figure 2: AREON Conceptual Map

The actual design of the AREON network depends on a number of factors, including the availability and route of fiber optic cabling through the state, availability of sufficient funding, level of need, and ability to use the resource. The AREON network should establish a peering relationship with the existing Arkansas state network so some of its benefits can be realized by all schools from kindergarten through universities (K-20). AREON should sponsor membership in the SEGP (Sponsored Educational Group Participant) program of Internet2, which will give all schools in the state the opportunity to participate in Internet2.

A portion of the AREON backbone can be built through fiber assets that the University of Arkansas, Fayetteville, has secured from the

Southeastern University Research Association (SURA). AT&T granted 8000 route miles of its NexGen fiber network to SURA, which has distributed allocations to universities for projects such as the National LambdaRail and regional optical networks. The Arkansas allocation of the SURA/AT&T fiber extends from Monroe, LA, through Monticello, Pine Bluff, Little Rock, Fort Smith, and on to Tulsa, OK.

The map in Figure 3 shows the routes of the National LambdaRail through the states of Louisiana, Texas, and Oklahoma. All three states have expressed interest in joining with the Arkansas research and education network in forming a four-state regional optical network ring which is informally being called the LOTA Ring (named for the four states through which it passes).

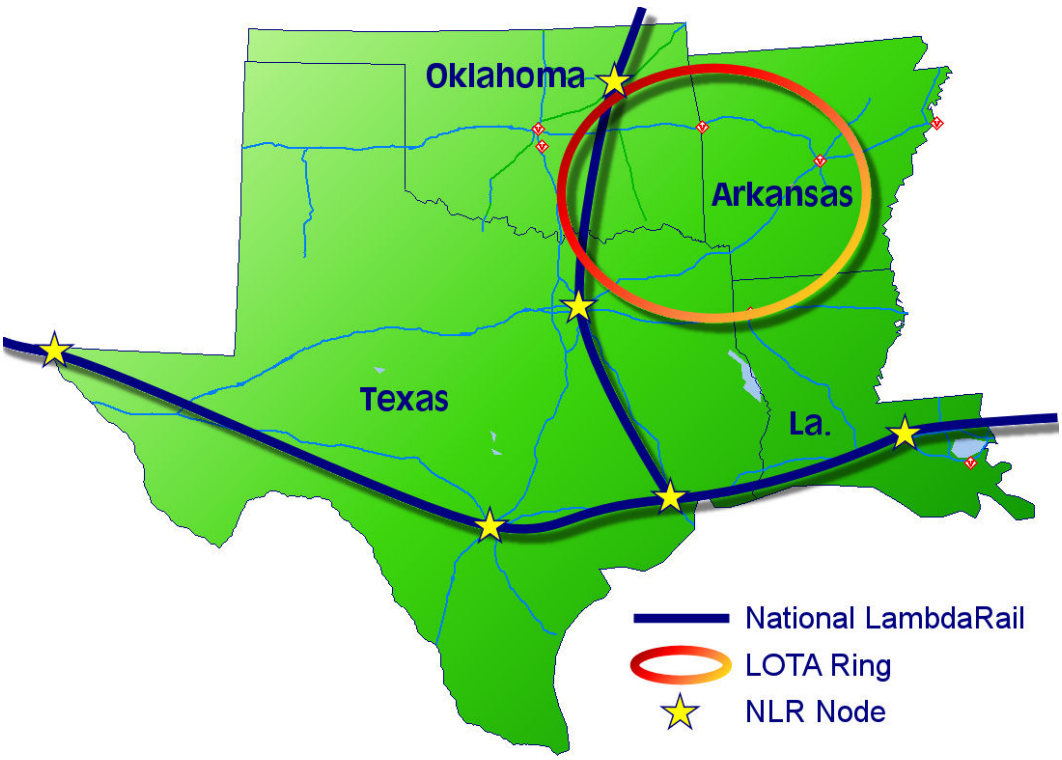

Figure 3: LOTA Ring and National LambdaRail

The Louisiana Optical Network Initiative (LONI), supported by the Louisiana Board of Regents and funding from the Louisiana state legislature, will provide connectivity for AREON in Monroe, LA. The Oklahoma Board of Regents OneNet will provide connectivity at the NLR node in Tulsa, OK. The Lonestar Education and Research Network (LEARN) in Texas rounds out the ring.

All four states in the LOTA Ring realize benefits from the presence of the optical network ring. Rings provide route diversity and greater reliability. In the event of equipment failure or a break in a strand of fiber optic cabling, data traffic can be rerouted in the opposite direction around the ring to reduce and/or eliminate a network outage.

The Internet2 network introduced the concept of gigapops, which are network access points where nodes of a large network connect through very high speed data circuits and share one or more connection to other national networks. Building on the concept of gigapops, regional optical networks can provide aggregation of data traffic as a means of saving money for all of the connecting parties. The LOTA Ring could provide one or more high-speed paths to commodity Internet providers, or one or more paths to the Internet2 network. Rather than each member having to pay for separate facilities for each of these services, all of the members of the ring can realize savings in operational costs and savings through joint buying contracts.

Other regional optical networking opportunities exist for the state of Arkansas. Tennessee is in the midst of its Southern Regional Optical Network (SRON) project with its surrounding states. Having a link from AREON to SRON (for instance, from Little Rock to Memphis) could provide researchers in Arkansas better access to facilities such as the

Oak Ridge National Labs. Similarly, the Great Plains Network (GPN) is planning a regional optical network through the Midwestern states to the north of Arkansas.

In Conclusion

Researchers and educators today rely upon high-speed, dependable, scalable, and secure networks to facilitate their work, collaborate with their peers, and to innovate. Regional and national optical networks raise the bar, providing multiple orders of magnitude increase in bandwidth, the ability to dedicate wide area networks to research, and opportunities to participate in top tier research at the national level.

Universities and colleges strive to create environments that attract top students, faculty, and researchers. Research funding is very competitive, and institutions with highly advanced, high-performance networking infrastructures often have the edge over their peers when competing for limited funding. Having access to national optical networks will be very important to the competitiveness of the research universities in Arkansas.

The economic development value of the public Internet evolving from university research networks far exceeded anyone's imagination. The way individuals conduct personal activities, how public organizations (schools, libraries, government agencies) deliver services, and how the private sector extends commercial services have been totally and permanently redirected by the Internet. It is conceivable that similar gains can be realized from the technologies and applications developed and deployed through optical networks.

The development of the National LambdaRail and regional optical networks that connect to it has been rapid. Fifteen states have already stepped up to the financial commitment to maintain NLR nodes. Almost every other state in the nation is working to develop their own optical networks to give their researchers and educators access to the national network. In our region, efforts to build regional networks are taking place on all sides of Arkansas, the most promising one at this time being the LOTA Ring.

Arkansas must move forward now in order to be a participant rather than an observer of the development of new technology networking facilities. The diminishing opportunities to acquire access to unlit fiber, the activities in the surrounding states and nationally to build regional optical networks, the initiatives to promote grid networks in the member states of the Southern Governors' Association, and the support of the governor of Arkansas all indicate that AREON should be built now.

Appendix

Below is a list of University of Arkansas research which could benefit from having access to optical networks such as the National LambdaRail.

Middleware for Large-Scale Data-Intensive Applications
Amy Apon, Ph.D., Craig Thompson, Ph.D., & Dale Thompson, Ph.D.
http://www.nsf.gov/awardsearch/showAward.do?AwardNumber=0219267

Computational Condensed Matter Physics Group(CCMP)
Laurent Bellaiche, Ph.D., & Huaxiang Fu, Ph.D.
http://www.uark.edu/misc/aaron5/index.html

DNA and Biomolecular Computing – Russell Deaton, Ph.D.
http://csce.uark.edu/~rdeaton/dna/papers/pubs.html

Multi-scale Modeling in Science and Engineering – Paneer Selvam, Ph.D.

Finite Element Modeling of Volcano and Tectonic Deformation - Glen S. Mattioli, Ph.D., & William Johnston, Ph.D.
http://comp.uark.edu/~mattioli/research/CALIPSO/Intro.html

Other

Arkansas Governor's e-Corridor website:
http://www.ecorridors.arkansas.gov/

Southern Governor's Association
http://www.southerngovernors.org/

National LambdaRail Initiative
http://www.nlr.net/

Southeastern Universities Research Association
http://www.sura.org

Internet2 K20 Initiative (Sponsored Education Group Participant – SEGP)
http://k20.internet2.edu/